

What is claimed is:

1. A measurement system installed on a spacecraft, said system comprising:
a light beam generation and scanning unit positioned on the spacecraft, said light
beam generation and scanning unit being operable to generate a light beam and to direct
5 the light beam from said light beam generation and scanning unit in a plurality of
directions to illuminate a corresponding plurality of locations within an area on a surface
of the spacecraft remote from said light beam generation and scanning unit; and

a plurality of optical detectors positioned at various positions on the spacecraft
within the area on the surface of the spacecraft remote from said light beam generation
10 and scanning unit, each said optical detector being operable to detect illumination by the
light beam when the light beam is directed from said light beam generation and scanning
unit in a direction corresponding to one of said locations coinciding with the position of
each said optical detector;

wherein information relating to the position of each said optical detector is
15 determinable from information relating the direction of the light beam from said light
beam generation and scanning unit when each said optical detector is illuminated by the
light beam.

2. The system of Claim 1 wherein the surface of the spacecraft remote from
20 said light beam generation and scanning unit comprises a surface of a phased array
antenna and wherein said plurality of optical detectors are positioned at positions
permitting determination of information relating to planarity of the surface of the phased
array antenna from the information relating to the positions of said optical detectors.

25 3. The system of Claim 1 wherein said light beam generation and scanning
unit comprises:

a light source; and
a bi-directional acousto-optic modulator.

30 4. The system of Claim 3 wherein said light source comprises a coherent
light source.

5. The system of Claim 4 wherein said light source comprises a laser.

6. The system of Claim 3 wherein said bi-directional acousto-optic
5 modulator comprises a first acousto-optic modulator in series with a second acousto-optic modulator.

7. The system of Claim 2 wherein said light beam generation and scanning unit further comprises:

10 a light beam drift monitoring assembly operable to measure a difference between an expected direction of the light beam and an actual direction of the light beam.

8. The system of Claim 7 wherein said light beam drift monitoring assembly comprises:

15 a beam splitter positioned in a path of the light beam between said light beam generation and scanning unit and said optical detectors; and

at least one optical detector positioned to receive at least a portion of the light beam from said beam splitter.

20 9. The system of Claim 1 wherein each said optical detector comprises a quadrant optical detector.

10. The system of Claim 1 wherein the information relating to the direction of the light beam from said light beam generation and scanning unit comprises:

25 a first angle of the light beam measured from a first axis; and

a second angle of the light beam measured from a second axis orthogonal to the first axis.

11. A system for use in determining the position of a selected location, said system comprising:

a coherent light source operable to generate a coherent light beam;

a bi-directional acousto-optic modulator oriented to receive the coherent light beam from said coherent light source and operable to deflect the coherent light beam in a plurality of directions to illuminate a corresponding plurality of illumination locations, wherein the plurality of illumination locations defines an illumination region; and

an optical detector positioned within the illumination region in a known relation with the selected location, said optical detector being operable to detect illumination by the deflected coherent light beam when the coherent light beam is deflected by said bi-directional acousto-optic modulator in a direction corresponding to one of said plurality of illumination locations coinciding with the position of said optical detector within the illumination region;

wherein information relating to the position of said optical detector is determinable from information relating the direction of the coherent light beam from said bi-directional acousto-optic modulator when said optical detector is illuminated by the deflected coherent light beam.

12. The system of Claim 11 wherein said coherent light source comprises a laser.

13. The system of Claim 11 wherein said bi-directional acousto-optic modulator comprises two acousto-optic modulators in series.

14. The system of Claim 13 wherein each said acousto-optic modulator comprises a crystal and a piezoelectric transducer.

15. The system of Claim 11 wherein said optical detector comprises a quadrant optical detector.

16. The system of Claim 11 further comprising:

a light beam drift monitoring assembly operable to measure a difference between an expected direction of the coherent light beam and an actual direction of the coherent light beam.

5 17. The system of Claim 16 wherein said light beam drift monitoring assembly comprises:

 a beam splitter positioned in a path of the deflected coherent light beam between said bi-directional acousto-optic modulator and said optical detector; and

 at least one quadrant detector positioned to receive at least a portion of the
10 deflected coherent light beam from said beam splitter.

 18. The system of Claim 11 wherein the illumination region defined by the plurality of illumination locations comprises at least a portion of a surface of a phased array antenna.

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 19. The system of Claim 11 wherein the information relating the direction of the coherent light beam from said bi-directional acousto-optic modulator comprises:

 a first deflection angle of the coherent light beam measured from a first axis; and

 a second deflection angle of the coherent light beam measured from a second axis
20 orthogonal to the first axis.

20. A method for determining the position of a selected location, said method comprising:

generating a coherent light beam;

operating a bi-directional acousto-optic modulator to deflect the coherent light
5 beam in a plurality of directions to illuminate a corresponding plurality of illumination
locations, wherein the plurality of illumination locations defines an illumination region;

positioning an optical detector within the illumination region in a known relation
with the selected location;

detecting illumination from the coherent light beam with the optical detector
10 when the coherent light beam is deflected by the bi-directional acousto-optic modulator
in a direction corresponding to one of the illumination locations coinciding with the
position of the optical detector within the illumination region; and

determining information relating to the position of the optical detector from
information relating to the direction of the coherent light beam from the bi-directional
15 acousto-optic modulator when the optical detector is illuminated by the coherent light
beam.

21. The method of Claim 20 wherein said step of generating a coherent light
beam comprises:

20 operating a laser to generate the coherent light beam.

22. The method of Claim 20 wherein the bi-directional acousto-optic
modulator comprises a first crystal arranged in series with a second crystal, and wherein
said step of operating a bi-directional acousto-optic modulator comprises:

25 imparting acoustic waves within the first crystal and within the second crystal;
and

periodically changing at least one of a frequency of the acoustic waves imparted
in the first crystal and a frequency of the acoustic waves imparted in the second crystal.

30 23. The method of Claim 22 wherein said step of determining information
relating to the position of the optical detector comprises:

calculating a first deflection angle of the coherent light beam using the frequency of the acoustic waves imparted in the first crystal when the optical detector is illuminated by the coherent light beam;

calculating a second deflection angle of the coherent light beam using the
5 frequency of the acoustic waves imparted in the second crystal when the optical detector is illuminated by the coherent light beam; and

using the first and second deflection angles to determine the position of the optical detector.

10 24. The method of Claim 20 wherein the illumination region defined by the plurality of illumination locations comprises at least a portion of a surface of a phased array antenna, wherein the selected location comprises a point on the phased array antenna, and wherein said step of positioning an optical detector comprises:

mounting the optical detector on the surface of the phased array antenna in an
15 overlying relationship with the selected location.

25. The method of Claim 20 wherein the optical detector comprises a quadrant detector having four segments, and wherein said step of detecting illumination from the coherent light beam comprises:

20 obtaining four photocurrents, wherein each photocurrent corresponds with a separate one of the segments of the quadrant detector.

26. The method of Claim 25 wherein said step of determining information relating to the position of the optical detector comprises:

25 computing a ratio of a sum of a first pair of the photocurrents to a sum of all four photocurrents; and

computing a ratio of a sum of a second pair of the photocurrents to a sum of all four photocurrents.

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